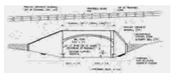
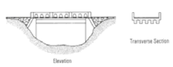
Tables

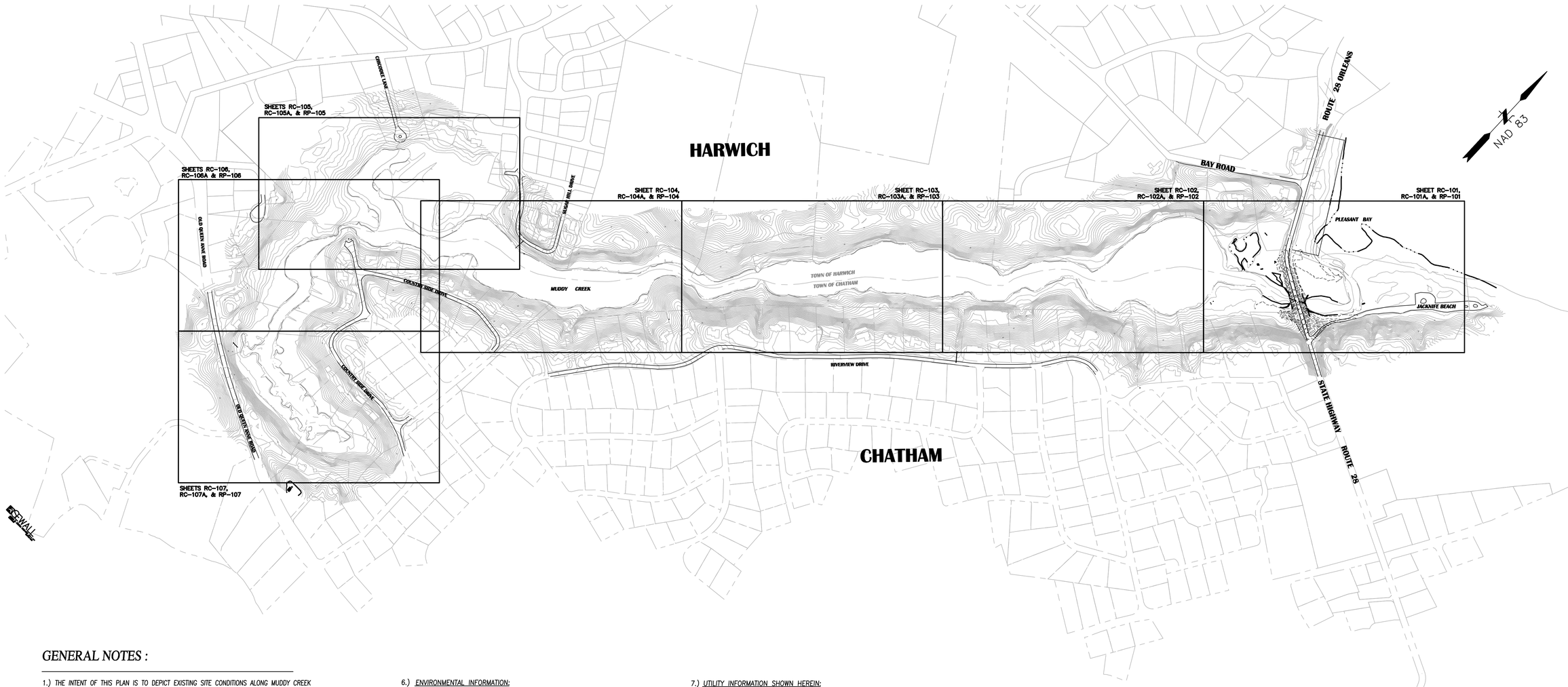
TABLE 46
Comparative Constraints Analysis Summary Table for Culvert Replacement Alternatives
Muddy Creek Wetland Restoration
February 2012

Culvert Replacement Alternative Configuration	Vegetative Community Impacts/ Benefits	Shellfish Community Impacts/ Benefits	Fisheries Migration/ Habitat Impacts/Benefits	Construction Costs	Life Expectancy/ Maintenance Costs	Construction Footprint Impacts on Wetlands	Construction Timeline and Traffic Bypass/ Detouring	Water Quality Impacts/ Benefits	Permitting Requirements	Wildlife/Rare Species Impacts/Benefits	Canoe/Kayak Passage and Safety	Aesthetics	TOTAL SCORE
Pre-Cast Concrete Box Single Cell •24' clear span box channel •Split for Transport •Installation by jacking 	• Score = 2 • Greater impacts because of jacking pit.	• Score = 2 • Temporary shellfishing impacts where jacking pit is located.	• Score = 1 • Fish migration severely impacted during construction because of need to pump water to avoid deep trench excavation for bypass channel	• Score = 3 • Second highest construction cost ($3,775,000)	• Score = 3 • 75 Year Life Expectancy • Intermittent maintenance will be required to repair the invert exposed to flow	• Score = 1 • Greatest impact during construction due to the jacking pit and need to support the reaction wall and construct access road • Approximately 7,900 sq. ft. of wetland area disturbance	• Score = 5 • Shortest construction period (3-5 months) • Maintains traffic through the site for the duration of construction	• Score = 5 • Culvert will improve water quality consistent with other scenarios.	• Score = 2 • Jacking will require greatest disturbance to wetlands. • Finished product will have the least benefits to wildlife and humans with smaller opening and concrete floor.	• Score = 2 • Finished product will have the least benefits to wildlife with smaller opening and concrete floor.	• Score = 2 • Can be designed to offer safe passage but opening will appear smaller than other alternatives during high tide.	• Score = 2 • Square box culvert will lower aesthetics. • Formliners can be used to improve aesthetics	30
Single Span Pre-Cast Concrete Three Sided Bridge •24' clear span box channel 	• Score = 3 • Less impacts than jacking.	• Score = 3 • Less impacts than jacking.	• Score = 3 • Temporary bypass will allow continued fish passage through construction. • Natural stream bottom through culvert.	• Score = 4 • Second lowest construction cost ($3,540,000)	• Score = 5 • 75 Year Life Expectancy • Negligible annual maintenance cost	• Score = 3 • Moderate impact during construction • Approximately 5,320 sq. ft. of wetland area impact	• Score = 3 • Construction time is shorter than concrete deck bridge alternatives (6-9 months) • Shortest detour duration due to short construction time	• Score = 5 • Culvert will improve water quality consistent with other scenarios.	• Score = 4 • Approach reduces potential construction impacts while providing habitat and water quality benefits.	• Score = 3 • Finished product will have natural stream bottom and higher opening because of arch.	• Score = 3 • Higher opening because of arch.	• Score = 4 • Arch will make culvert appear less as a pipe. • Formliners can be used to improve aesthetics	43
Pre-Cast Concrete Deck Beam Bridge on Cast-in-Place Abutments •24' clear span box channel 	• Score = 3 • Less impacts than jacking.	• Score = 3 • Less impacts than jacking.	• Score = 4 • Temporary bypass will allow continued fish passage through construction. • Natural stream bottom through culvert. • Larger opening may encourage improved habitat and migration.	• Score = 1 • Highest construction cost ($4,040,000)	• Score = 4 • 75 Year Life Expectancy • Minimal maintenance costs when compared to steel stringer bridges • Pavement maintenance / replacement is a bridge item • Potential damage to bridge rails	• Score = 2 • Second largest impact during construction • Approximately 6,290 sq. ft. of wetland area impact	• Score = 1 • Longest construction time of alternatives (10-12 months) • Longest detour duration due to abutment construction	• Score = 5 • Opening will improve water quality consistent with other scenarios.	• Score = 3 • Approach has more significant construction impacts with comparable habitat and water quality benefits.	• Score = 3 • Finished product will have natural stream bottom and large opening through the embankment.	• Score = 4 • Larger opening because of bridge.	• Score = 3 • Size and height of structure may seem intrusive and overpowering in proposed setting	36
Single Span Adjacent Pre-Cast Concrete Deck Beam Bridge Supported on Cast-in-Place Concrete Abutments •94' deck span over armored trapezoidal channel 	• Score = 3 • Less impacts than jacking.	• Score = 4 • Least footprint within Land Under Ocean	• Score = 5 • Temporary bypass will allow continued fish passage through construction. • Greater ability to form variability/complexity through natural stream bottom channel. • Larger opening may encourage improved habitat and migration.	• Score = 5 • Lowest construction cost ($3,310,000)	• Score = 4 • 75 Year Life Expectancy • Minimal maintenance costs when compared to steel stringer bridges • Pavement maintenance / replacement is a bridge item • Potential damage to bridge rails	• Score = 4 • Lowest impact during construction • Approximately 4.,320 sq. ft. of wetland area impact	• Score = 2 • Longer construction time three sided bridge (8-10 months)	• Score = 5 • Opening will improve water quality consistent with other scenarios.	• Score = 5 • Approach has lowest construction impacts providing larger opening for wildlife and recreational passage.	• Score = 5 • Finished product will have natural stream bottom, the largest opening through the embankment and will allow for wildlife migration.	• Score = 5 • Highest opening resulting from large bridge span and trapezoidal channel configuration. • Lower tidal velocities compared to 24-ft. wide channel.	• Score = 4 • Larger opening creates less visual impact and greater sight lines from downstream beach area to upstream estuary.	51

FUSS & O'NEILL

Attachment A

Topographic Wetland Resource Area Mapping



GENERAL NOTES :

1.) THE INTENT OF THIS PLAN IS TO DEPICT EXISTING SITE CONDITIONS ALONG MUDDY CREEK AND ITS OUTLET TO PLEASANT BAY.

2.) PLAN CO-ORDINATE SYSTEM: NORTH AMERICAN DATUM 1983 (NAD 83)

PLAN VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88)

DATES OF SURVEY/EQUIPMENT UTILIZED/COMPUTER SOFTWARE:

APRIL 20-25, 2011 AND MAY 4, 2011 ~ LEICA RX1250TC GPS RTK AND TOPCON GPT 3100W TOTAL STATION WITH TDS-S72-SY3CMBB-SP 0001 RANGER 300X W/BLUETOOTH & TC TP5/AutoCAD WITH CARLSON SURVEY 2007

3.) A TITLE SEARCH HAS NOT BEEN PERFORMED FOR THIS SITE. IF DETERMINED TO BE NECESSARY, A TITLE SEARCH SHALL BE PERFORMED BY OTHERS.

4.) TOPOGRAPHIC SURVEY DETAIL PERFORMED BY BAXTER-NYE ENGINEERING & SURVEYING ON APRIL 20-25, 2011 AND MAY 4, 2011.

5.) COMMUNITY PANEL NUMBER 250008 0008 D
THE FLOOD INSURANCE RATE MAP DEFINES THIS AREA AS ZONE A14 (EL 12 & 13) AND V211 (EL 14 & 16).

6.) ENVIRONMENTAL INFORMATION:

- SITE IS WITHIN AN A.C.E.C. (AREA OF CRITICAL ENVIRONMENTAL CONCERN).
- SITE IS WITHIN AN AREA OF ESTIMATED HABITAT OF RARE WILDLIFE PER NHESP MAP OCTOBER 1, 2010 "ESTIMATED HABITATS OF RATE WILDLIFE" FOR USE WITH THE MA WETLANDS PROTECTION ACT REGULATIONS (310 CMR 10)."
- SITE DOES NOT CONTAIN A CERTIFIED VERNAL POOL PER NHESP MAP OCTOBER 1, 2010 "CERTIFIED VERNAL POOLS."
- SITE IS WITHIN A PRIORITY HABITAT PER NHESP MAP OCTOBER 1, 2010 "PRIORITY HABITATS OF RARE SPECIES" FOR SPECIES UNDER THE MASSACHUSETTS ENDANGERED SPECIES ACT, REGULATIONS (321 CMR10).
- SITE IS WITHIN A STATE APPROVED ZONE II GROUND WATER RECHARGE PROTECTION AREA.
- SITE IS WITHIN A ZONE OF CONTRIBUTION TO A SALTWATER ESTUARY (BOH 360-45).

7.) UTILITY INFORMATION SHOWN HEREIN:

- ANY CONTRACTOR SHALL CONTACT DIG SAFE (AT 1-888-DIG-SAFE) AND UTILITY COMPANIES TO LOCATE ALL EXISTING UTILITIES, AT LEAST 72 HOURS PRIOR TO THE START OF CONSTRUCTION. THE LOCATION OF EXISTING UNDERGROUND INFRASTRUCTURE, UTILITIES, CONDUITS AND LINES ARE SHOWN IN AN APPROXIMATE WAY ONLY, MAY NOT BE LIMITED TO THOSE SHOWN HEREIN AND HAVE BEEN RESEARCHED BASED ON THE AVAILABLE UTILITY RECORDS NOTED HEREON. CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY CONTRACTOR'S FAILURE TO LOCATE SAID INFRASTRUCTURE AND UTILITIES EXACTLY.
- WATER LINE SHOWN IN ROUTE 28 IS MARKED BY DIG-SAFE AT LOCUS AREA
- GAS MAIN SHOWN IN ROUTE 28 IS MARKED BY DIG-SAFE AT LOCUS AREA.
- INFORMATION RECEIVED FROM NSTAR ELECTRIC VIA EMAIL DATED 4/13/11, INDICATES THAT LOCUS AREA CONSISTS OF OVERHEAD SECONDARY UTILITY LINES, AS SHOWN ON PLAN.

TOPOGRAPHY, SPOT SHOT ELEVATIONS, ROADWAYS, EDGE OF WATER (EXCEPT AS NOTED), BUILDINGS AND TREE LINE FROM ELECTRONIC FILE SUPPLIED BY CLIENT. INFORMATION SHOWN THEREON FROM AERIAL SURVEY DATA COMPILED BY JAMES W. SEWALL COMPANY, MAY 13, 2008.

CHATHAM/HARWICH TOWN LINE IS APPROXIMATE. INFORMATION COMPILED, SCALED AND ROTATED FROM CHATHAM AND HARWICH ELECTRONIC ASSESSOR DATA FILES.

LEGEND

- EDGE OF WATER (AERIAL SURVEY)
- OBSERVED MEAN HIGH WATER LINE
- TIDAL LINE
- TRIBUTARY / STORM DRAINAGE CHANNEL
- EDGE OF ROAD
- TREE LINE (AERIAL SURVEY)
- PARCEL BOUNDARY
- ELEVATION CONTOUR
- WETLAND VEGETATIVE COMMUNITY BOUNDARY
- WF/G-2 — DELINEATED WETLAND LIMIT AND FLAG
- F — FLOOD HAZARD ZONE BOUNDARY

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ENGINEERING & SURVEYING

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CAPE COD CONSERVATION DISTRICT

SHEET LAYOUT AND NOTES PLAN

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
DATE: FEB. 2012

LP-101

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SEE SHEET RC-102

LEGEND

- EDGE OF WATER (AERIAL SURVEY)
- OBSERVED MEAN HIGH WATER LINE
- TIDAL LINE
- TRIBUTARY / STORM DRAINAGE CHANNEL
- EDGE OF ROAD
- TREE LINE (AERIAL SURVEY)
- PARCEL BOUNDARY
- ELEVATION CONTOUR
- WETLAND VEGETATIVE COMMUNITY BOUNDARY
- DELINEATED WETLAND LIMIT AND FLAG
- FLOOD HAZARD ZONE BOUNDARY

CULVERT ELEVATION SUMMARY TABLE - MUDDY CREEK/ROUTE 28
ALL ELEVATIONS NAVD88

	MUDDY CREEK (LAND SIDE)		PLEASANT BAY (OCEAN SIDE)	
	ROOF ELEV.	INVERT ELEV.	ROOF ELEV.	INVERT ELEV.
NORTH CULVERT	0.99	-2.63	0.55	-3.21
SOUTH CULVERT	0.82	-2.35	0.68	-2.92

NOTES:
Roof elevations at each culvert end were measured at both corners. Elevations shown above are averaged values.

NAD 83

MUDDY CREEK

PLEASANT BAY

ROUTE 28

COASTAL RESOURCES

COASTAL FOREST/WOODLAND

SALT MARSH (LOW MARSH)

SALT MARSH (HIGH MARSH)

SALT MARSH (HIGH MARSH/ PHRAGMITES AUSTRALIS DOMINANT)

SALT MARSH (HIGH MARSH/ TYPHA ANGUSTIFOLIA DOMINANT)

SALT MARSH (HIGH MARSH PHRAGMITES AUSTRALIS ENCROACHMENT)

LOWER BASIN TRANSECT 1

LOWER BASIN TRANSECT 2

LOWER BASIN TRANSECT 3

LOWER BASIN TRANSECT 4

SHELLFISH TRANSECT 'A'

SHELLFISH TRANSECT 'B'

SHELLFISH TRANSECT 'C'

PLEASANT BAY TRANSECT 1

PLEASANT BAY TRANSECT 2

PLEASANT BAY TRANSECT 3

ROD FOUND SHELLFISH TRANSECT

MARITIME DUNE

FRESHWATER/BRACKISH TIDAL SHRUBLAND

TIDAL SHRUBLAND

PAVED ROAD

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
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CAPE COD CONSERVATION DISTRICT

WETLAND RESOURCE AREA PLAN NO. 1

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
DATE: FEB. 2012

RC-101

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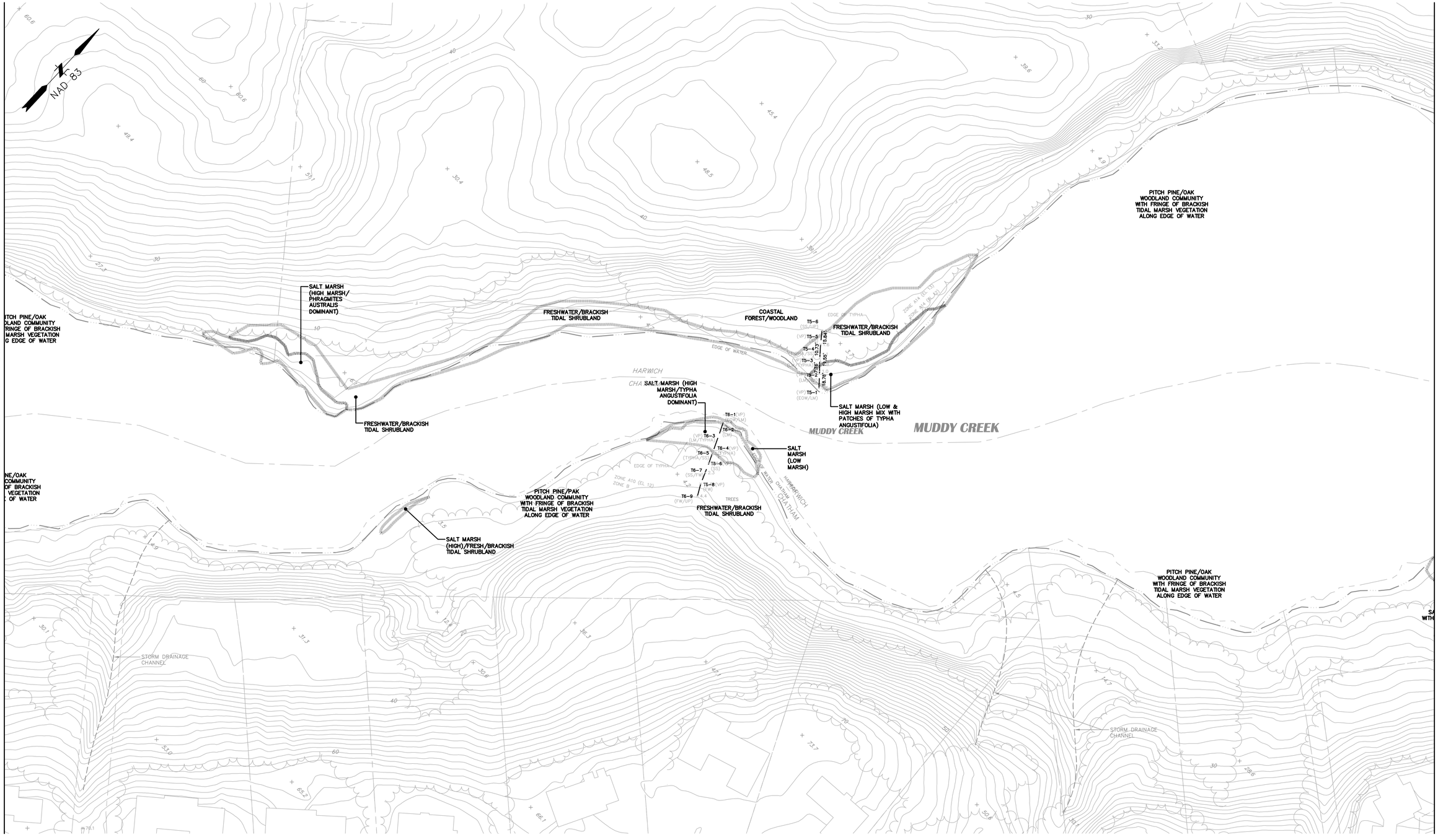

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CAPE COD CONSERVATION DISTRICT

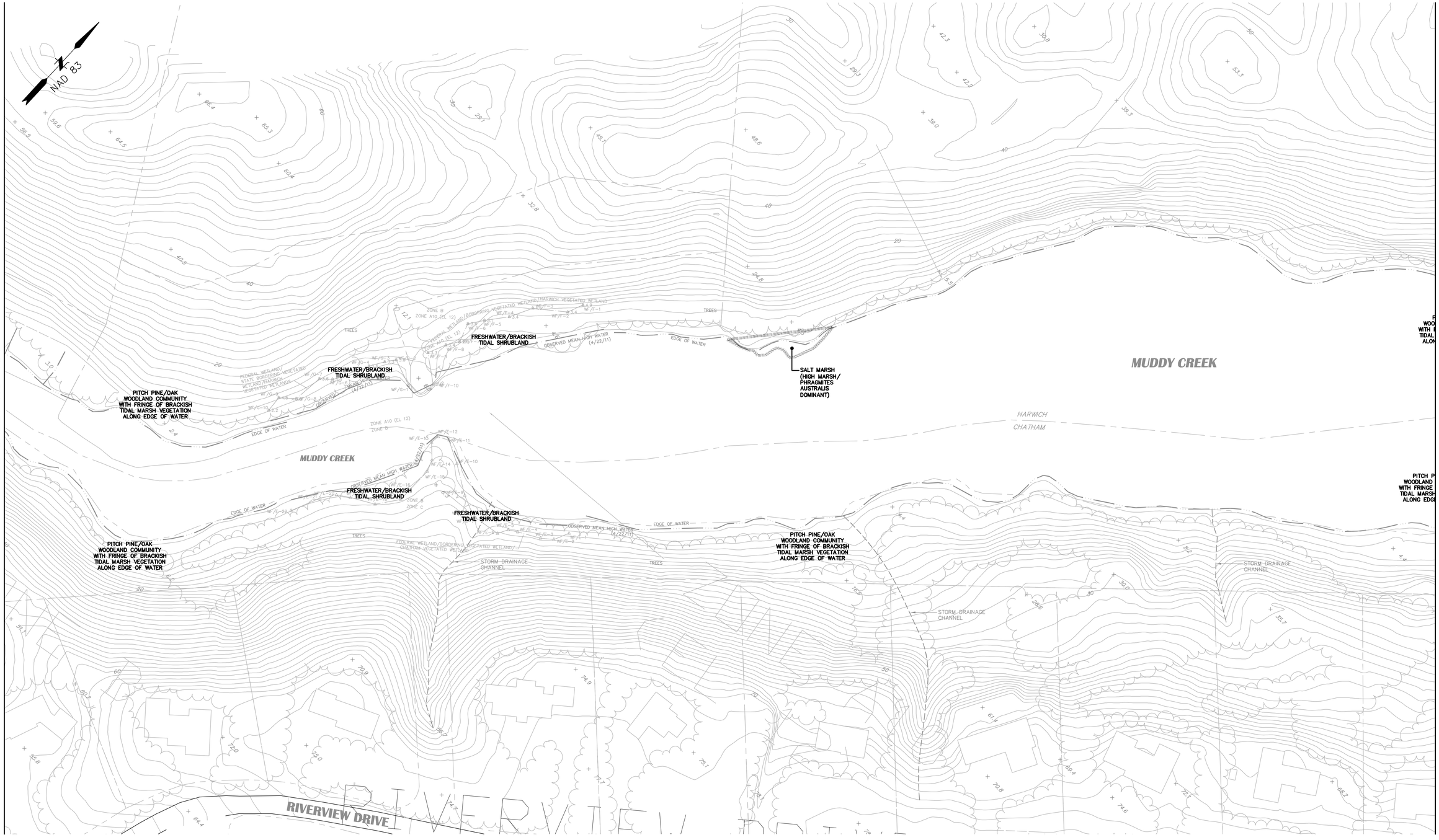
WETLAND RESOURCE AREA PLAN NO. 2

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
DATE: FEB. 2012

RC-102



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CAPE COD CONSERVATION DISTRICT

WETLAND RESOURCE AREA PLAN NO. 3

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

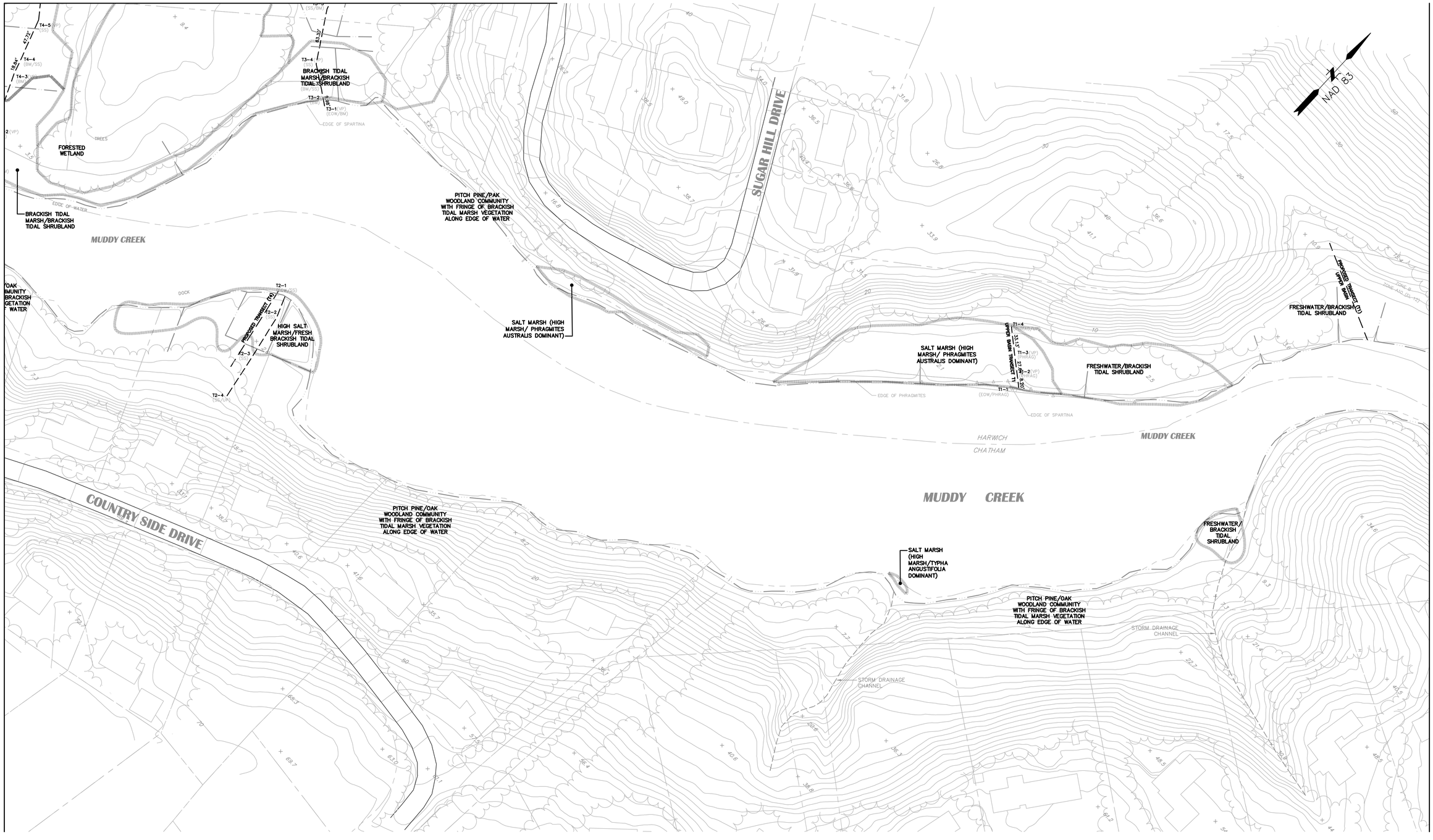
PROJ. No.: 20110202.A10
DATE: FEB. 2012

RC-103

SEE SHEET RC-105

SEE SHEET RC-106

SEE SHEET RC-103



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WETLAND RESOURCE AREA PLAN NO. 4

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
DATE: FEB. 2012

RC-104

NAD 83

PITCH PINE/PAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

BRACKISH TIDAL MARSH

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT WITH JUNCUS GERARDII)

FRESHWATER/BRACKISH TIDAL SWAMP

FORESTED WETLAND

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT WITH JUNCUS GERARDII)

FRESHWATER/BRACKISH TIDAL SWAMP

FRESHWATER/BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT)

SALT MARSH (HIGH MARSH/TYPHA ANGUSTIFOLIA DOMINANT)

FRESHWATER/BRACKISH TIDAL SHRUBLAND

FORESTED WETLAND

BRACKISH TIDAL MARSH/BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH/BRACKISH TIDAL SHRUBLAND

HARWICH

CHATHAM

MUDDY CREEK

MUDDY CREEK

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

PITCH PINE/PAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

FRESHWATER/ BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH/FRESH-BRACKISH TIDAL SWAMP

HIGH SALT MARSH/FRESH BRACKISH TIDAL SHRUBLAND

SALT MARSH/ PHRA AUSTRALIS DOM

PROPOSED TRANSECT (TYP.)

DOCK

EDGE OF WATER

EDGE OF PHRAGMITES

EDGE OF TYPHA

EDGE OF SPARTINA

TREES

SEE SHEET RC-104

SEE SHEET RC-106

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CAPE COD CONSERVATION DISTRICT

WETLAND RESOURCE AREA PLAN NO. 5

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
DATE: FEB. 2012

RC-105

SEE SHEET RC-105

NAD 83

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT WITH JUNCUS GERARDII)

FORESTED WETLAND

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT WITH JUNCUS GERARDII)

FORESTED WETLAND

FRESHWATER/BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS DOMINANT)

SALT MARSH (HIGH MARSH/TYPHA ANGUSTIFOLIA DOMINANT)

HARWICH

CHATHAM

MUDDY CREEK

BRACKISH TIDAL MARSH/BRACKISH TIDAL SHRUBLAND

FRESHWATER/BRACKISH TIDAL SHRUBLAND

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

PITCH PINE/OAK WOODLAND COMMUNITY WITH FRINGE OF BRACKISH TIDAL MARSH VEGETATION ALONG EDGE OF WATER

FRESHWATER/ BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH/FRESH-BRACKISH TIDAL SWAMP

BRACKISH MARSH (PHRAGMITES AUSTRALIS DOMINANT)/FRESH-BRACKISH TIDAL SHRUBLAND

BRACKISH TIDAL MARSH (PHRAGMITES AUSTRALIS T7-DOMINANT)

UPPER BASIN TRANSECT B

FRESHWATER/ BRACKISH TIDAL SWAMP

FRESHWATER/ BRACKISH TIDAL SHRUBLAND

FRESHWATER/ BRACKISH TIDAL SWAMP

FRESHWATER/ BRACKISH TIDAL SHRUBLAND

FORESTED WETLAND

MUDDY CREEK

MUDDY CREEK

COUNTRY SIDE DRIVE

OLD QUEEN ANNE ROAD

SEE SHEET RC-104

SEE SHEET RC-107

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CAPE COD CONSERVATION DISTRICT

WETLAND RESOURCE AREA PLAN NO. 6

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
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RC-106

SEE SHEET RC–106

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CAPE COD CONSERVATION DISTRICT

WETLAND RESOURCE AREA PLAN NO. 7

MUDDY CREEK WETLAND RESTORATION

HARWICH/CHATHAM MASSACHUSETTS

PROJ. No.: 20110202.A10
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RC-107

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